13.0 UPPER COLUMBIA RIVER (UCR) SPRING-RUN CHINOOK SALMON ESU

13.1 BACKGROUND

13.1.1 Description of the ESU

The ESU includes all naturally spawned populations of spring-run chinook salmon in all river reaches accessible to chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River (64 FR 14208, March 24, 1999). Historically the ESU may have included a population in the Okanogan basin and one or more populations originating in areas above Grand Coulee Dam. The Interior Columbia Technical Review Team has identified three extant populations within the ESU; Wenatchee; Entiat; and Methow. Additionally, the spring-run chinook salmon (and their progeny) from the following artificially propagated stocks are considered part of the listed ESU: Chiwawa River and White River within the Wenatchee basin population; Methow River, Methow Composite stock, Chewuch River, and Twisp River within the Methow basin population. Spring-run chinook salmon (and their progeny) from the following artificially propagated stocks are considered not included in the ESU: Leavenworth National Fish Hatchery (NFH) spring chinook salmon; Entiat NFH spring chinook salmon; Winthrop NFH Carson stock spring chinook salmon.

13.1.2 Status of the ESU

Upper Columbia River spring-run chinook salmon were listed as an endangered species on March 24, 1999 (FR 14208). In 1998 the BRT reviewed this ESU and at that time was primarily concerned about low abundance/distribution and low productivity of the populations in the ESU (Myers *et al.* 1998). The aggregate return (mainstem dam count minus returns to hatchery facilities) was just under 5,000 fish in 1990-1994, there were dramatic declines in returns to natural spawning areas. As a result, "… escapements in 1994-1996 were the lowest in at least 60 years." The BRT was concerned that at these population sizes, negative effects of demographic and genetic stochastic processes are likely to occur.

More recently, in 2003, the BRT again reviewed the status of this ESU and drew the following preliminary conclusions (BRT 2003). The BRT noted that many populations in this ESU have rebounded somewhat from the critically low levels that immediately preceded the last status review evaluation and considered this an encouraging sign. However, the last year or two of higher returns come on the heels of a decade or more of steep declines to all-time record low escapements. In addition, this ESU continues to largely depend on artificial propagation production. The BRT believes that the ESU faces considerable ongoing risk, which was acknowledge in the extreme management measures of attempting to collect all spring chinook salmon returning to Wells Dam in an effort to maintain the Methow River basin population in two years in the late 1990s. Assessments by the BRT of the overall risks faced by this ESU were divided, with a slight majority of the votes being cast in the "danger of extinction" category (i.e., endangered), and a substantial minority in the "likely to be endangered" category (i.e.,

threatened). The BRT still expressed substantial concern over population abundance and growth rate/productivity, and only somewhat less concern over population spatial structure and diversity (BRT 2003).

13.2 ASSESSMENT OF HATCHERY PROGRAMS

The following section presents a summary of artificial propagation programs in the UCR spring chinook salmon ESU which release spring chinook salmon (Table 13.1). The broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance are described on a population by population basis.

Table 13.1. Hatchery programs which release spring chinook salmon within the geographical area of the UCR spring chinook salmon (SCS) ESU.

Population **Program**	**Type**	**Included in ESU?**	**Description**	**Size**	**Year initiated**
Wenatchee					
Chiwawa SCS	Integrated	Yes	Yearling smolt	672,000	1989
White River SCS	Integrated	Yes	Captive broodstock/ yearling smolt	150,000	1999
Leavenworth NFH Carson SCS	Isolated	No	Yearling smolt	1,620,000	1974
Methow					
Methow Composite SCS at Methow Hatchery	Integrated	Yes	Yearling smolt	184,000	2001[a]
Methow Composite SCS at Winthrop NFH	Integrated	Yes	Yearling smolt	600,000	2001
Chewuch SCS	Integrated	Yes	Yearling smolt	183,000	1992
Twisp SCS	Integrated	Yes	Yearling smolt	183,000	1992
Entiat					
Entiat NFH Carson SCS	Isolated	No	Yearling smolt	300,000	1974

[a] *Methow composite stock is a combination of Methow River and Chewuch River stocks which is propagated at two hatchery facilities in the Methow River.*
[b] *Winthrop NFH reared Carson stock of spring chinook salmon until 2001, at which time a transition to rearing the Methow Composite stock began. Future broods will be Methow Composite stock.*

13.2.1 Wenatchee Basin Population

The Wenatchee basin spring chinook salmon population is affected by several artificial propagation programs which release spring chinook salmon within the Wenatchee River basin. The Chiwawa River and White River are integrated with the native population and are included in the ESU. The Leavenworth NFH spring chinook salmon program releases fish from a highly domesticated stock which is not included in the ESU.

13.2.1.1 Chiwawa River Spring Chinook Salmon Program

Artificial propagation of Chiwawa River spring chinook salmon (Table 1) began in 1989 as mitigation for Rock Island Dam. The program is managed by a committee with representatives from co-managing entities and the funding entity (CPUD 2002). It has a well developed monitoring and evaluation plan which informs the operation of the program and can make changes to the implementation. This process is intended to ensure that the program is constantly improving over time. The consensus goal statement developed by the HCP Hatchery Committee statement is the "*recovery of ESA listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.*"

13.2.1.1.1 Broodstock History. The program was originally designed as an integrated supplementation program with natural-origin spring chinook salmon returning to the Chiwawa River used for broodstock. Since the mid-1990s when adult runs were at record lows, some hatchery-origin salmon returning from this program have been collected for broodstock. However, a minimum of 30% of the annual broodstock has remained natural-origin fish. Recent management agreements could result in a reduction in the percentage of naturally produced salmon incorporated into the broodstock on an annual basis, particularly in years of low run size. The Chiwawa River is the only source for natural-origin broodstock. Tumwater Dam on the Wenatchee River is used to collect returning hatchery-origin fish for broodstock. However, before gametes from fish collected at Tumwater Dam are incorporated into the program, the coded-wire tags are extracted and read to ensure that only Chiwawa Program origin fish are used.

13.2.1.1.2 Similarity of Hatchery-origin and Natural-origin Fish. Program operational practices follow the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993). Monitoring of this program includes periodic genetic analysis of hatchery-origin fish and natural-origin fish. Based on sampling conducted within the past ten years, the naturally produced and hatchery reared fish are genetically similar (Ford *et al*. 2001). The life history characteristics of run timing and spawn timing are also similar. However, differences exist in age at return data (Tonseth et al. 2002). Fifty-six percent of the natural-origin fish return at age five, compared to hatchery produced fish, of which only 15 percent return at age five. The per capita reproductive potential of these hatchery-origin fish is less than the natural-origin fish as a result of the younger age at return.

13.2.1.1.3 Program Design. The program is intended to increase the number of adults on the spawning grounds and subsequently lead to an increase in natural production. Best management practices are applied to program implementation (see Management Practices for Integrated Program under Appendix A). The program release levels have ranged from zero in 1995 and 1999 to about 364,000 yearling chinook salmon smolts out of a target production level of 672,000. However, fisheries resource co-managers agree that 672,000 smolts likely exceed the biological capacity of the basin (BAMP 1998). Reduction in the production level is being contemplated within the appropriate forums. Concurrent with reduced production level in the Chiwawa River, a new program would likely be initiated in Nason Creek, also a tributary of the

Wenatchee River. External marking of smolts released by removal of the adipose fin has occurred in most, but not all years. All release groups have been 100 percent coded-wire tagged.

13.2.1.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Chelan County (Chelan PUD) and continued operation of this program is assured through the Rock Island Dam Habitat Conservation Plan (HCP) with Chelan PUD (CPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed an average of 44 percent of the natural spawning population from 1993 through 2003. Smolt release to adult return has averaged 0.24 percent (1993-2003 returns) (A. Murdoch, WDFW, pers. com.). The average number of adult returns to broodstock collected is 2.3 fish. These data suggest that the program has increased the number of spawners and that propagation program spawners have commingled with naturally produced adults on the spawning grounds. Hatchery facility operations have resulted in an average 28 percent of the returning program adults straying to other Wenatchee River basin tributaries or to areas outside the Wenatchee River basin (Miller 2003).

Juvenile emigrant trapping is conducted to assess productivity of the natural spawners. Juvenile emigration data indicate that propagation program fish are successfully producing juveniles (Miller 2003). Smolt to adult survival of hatchery released fish is low compared to natural-origin fish (0.52 percent for hatchery-origin fish compared to 1.03 percent for natural-origin fish - 1992-1998 broods, A. Murdoch, WDFW, pers. com.). The sustain productivity of hatchery-origin fish over several generation in the natural environment has not yet been demonstrated.

A weir is used to collect adult broodstock from the Chiwawa River, spring chinook salmon not collected for broodstock are released unharmed upstream of the weir. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

***13.2.1.1.5 Effects on VSP*.** The Chiwawa spring chinook salmon program has been successful in returning adult salmon to the spawning grounds since 1993. These fish appear to have successfully reproduced thereby increasing the abundance of natural-origin salmon in the population. The productivity of hatchery-origin fish relative to natural-origin fish in the natural environment is not known. The program operates to preserve diversity by incorporating natural-origin salmon into the broodstock annually. The program has not altered the spatial distribution of the population. If the propagation program releases the full production level of 672,000 smolts annually which as noted above, the biological carrying capacity of the Chiwawa River is likely exceeded (BAMP 1998), and the risk of impacts on productivity and diversity will increase.

13.2.1.2 White River Spring Chinook Salmon Program

Artificial propagation of White River spring chinook salmon (Table 13.1) was initiated in 1999 as captive broodstock based program. The program is managed by a committee with representatives from co-managing entities and the funding entity. It has a monitoring and evaluation plan which informs the operation of the program and can make changes to the

implementation. This process is intended to ensure that the program is constantly improving over time.

13.2.1.2.1 Broodstock History. Eyed-eggs were collected from redds deposited by naturally spawning salmon in the White River beginning in 1999 (Petersen and Dymowska 1999). The first yearling smolt release occurred in the spring of 2004. The White River is the only source for eggs used as brood fish. Multiple brood sources are not used for this program.

13.2.1.2.2 Similarity of Hatchery-origin and Natural-origin Fish. Genetic analyses of fish sampled from the White River indicate that it is a unique stock relative to other stocks throughout the Columbia River basin. It is assumed that the eggs collected from naturally deposited redds are genetically similar to those eggs that remained in the redds. Because this program is new and has not had any adult returns yet, information regarding life history characteristics, smolt to adult survival, and ability to successfully reproduce in the natural environment is not yet available. Monitoring and evaluation work is ongoing and these data are anticipated to be available in the future.

13.2.1.2.3 Program Design. The White River spring chinook salmon artificial propagation program is integrated with the natural population and is intended to increase the number of White River spring chinook salmon adults on the spawning grounds. The program uses captive broodstock techniques starting with the collection of eyed eggs from naturally deposited redds in the White River. After hatching, fish are reared in a hatchery facility until maturity which can occur at three to six years. These fish are spawned and their progeny are reared to a yearling smolt stage. The smolts are tagged or marked for monitoring purposes and subsequently released into the White River. Gametes collected from natural-origin White River spring chinook salmon may be used to augment the gametes from the adults reared in captivity. In general, captive brood programs are operated for a finite length of time, usually several generations and are then transitioned into the more traditional anadromous adult based program or discontinued if adult returns from the program are realized and program objectives are met.

13.2.1.2.4 Program Performance. Program performance results are not available yet because only one release of juveniles has occurred. Continued operation of this program as either a captive brood program or as a program that rears fish only to the smolt stage before their release is likely because the program is identified as an action for funding under the Biological Opinion for ESA Section 7 Consultation on Interim Operations for the Priest Rapids Hydroelectric Project (NMFS 2004). No facilities currently exist for this program, therefore no blockages or hindrances to adult or juvenile passage are associated with the program.

13.2.1.2.5 Effects on VSP. No information is available yet on the effect of this program on the four VSP criteria. The program is designed such that it operates to benefit the viability of the population.

13.2.1.3 Leavenworth National Fish Hatchery Spring Chinook Salmon Program

Leavenworth NFH has released spring chinook salmon into Icicle Creek, a tributary of the Wenatchee River, since 1940, except for brood years 1967 and 1968. The program is intended to provide salmon for harvest, both in the ocean and in Icicle Creek. Operation of the program is well established and has remained consistent over time.

13.2.1.3.1 Broodstock History. Broodstock were originally collected from commingled upriver stocks intercepted at Rock Island Dam (1940-1943) (Cooper *et. al* 2002). Imports of lower Columbia River and McKenzie River, Oregon (a Willamette River tributary) fish occurred in the early years. Fish and eggs were imported from primarily Carson NFH and to a lesser extent Cowlitz and Little White Salmon NFHs up until 1985 (Cooper *et. al* 2002). Beginning in 1985, broodstock consisted of Leavenworth program adult returns that volunteer into the NFH on Icicle Creek. Program broodstock are isolated from the natural population in the Wenatchee River basin. The imported stock is not included in the UCR spring chinook salmon ESU.

13.2.1.3.2 Similarity of Hatchery-origin and Natural-origin Fish. Genetic sampling of the Leavenworth NFH program indicate that the fish from this isolated program are more closely related to the lower Columbia River stocks from which the program was founded than the natural population in the Wenatchee River (Ford *et al.* 2001).

13.2.1.3.3 Program Design. The Leavenworth NFH spring chinook salmon program is an isolated program designed to provide salmon for harvest. Recent releases have been 100 percent adipose fin clipped and coded-wire tagged prior to release.

13.2.1.3.4 Program Performance. This isolated program is funded by the Bureau of Reclamation to provide spring chinook salmon for harvest. The stock propagated is not included in the ESU. The program incorporates very few natural-origin spring chinook into the annual broodstock because broodstock are collected as volunteers to the hatchery facility and little natural production occurs in Icicle Creek. Stray Leavenworth NFH fish have been collected at Tumwater Dam, which is on the Wenatchee River above the Icicle Creek confluence. However, few fish from this program are found on the spawning grounds above Tumwater Dam (A. Murdoch, WDFW, pers. com.). Outside of the Wenatchee basin, program fish have been recovered at Wells Dam on the Columbia River, at the Methow Hatchery on the Methow River, at the Pelton Dam on the Deschutes River, and in the Umpqua River sport fishery (Cooper *et al*. 2002). Upstream fish migration in Icicle Creek is currently blocked at Leavenworth NFH (approximately river mile 2.9) by a dam at the base of a by-pass canal and holding dams and weirs in the historic creek channel (Craig 2002). Recent work has restored some flow in the natural river section but the hatchery water intake structure continues to block fish access to the upper Icicle Creek.

13.2.1.3.5 Effects on VSP. This isolated program likely has little effects on the abundance, diversity, or productivity of the Wenatchee population. The spatial structure of the reference population is adversely affected in that the operation of this out of ESU program in Icicle Creek

removes the entire Icicle Creek from contributing to the ESU. Additionally, competition with and predation on the listed stock are potential adverse impacts that are difficult to quantify.

13.2.2 Methow Basin Population

The Methow basin spring chinook salmon population is affected by several artificial propagation programs which release spring chinook salmon within the Methow River basin. The Washington Department of Fish and Wildlife (WDFW) operates the Methow Hatchery as a central facility to carry out release programs of spring chinook salmon into three tributaries in the basin, the Methow, Chewuch and Twisp Rivers. Additionally the U.S. Fish and Wildlife Service (USFWS) operates a separate but related program, that releases spring chinook salmon into the Methow River.

13.2.2.1 Methow Composite Stock Spring Chinook Salmon Program at Methow Hatchery

The WDFW releases Methow Composite stock into the Methow River from an acclimation pond located at the main hatchery facility. This program is one third, of a total annual production level of 550,000 yearling smolts, hence the annual production level is about 184,000 smolts. The WDFW Methow Hatchery Programs began in 1992 with broodstock collected from the natural runs in the Chewuch and Twisp Rivers. The Methow River program had its first broodstock collected in 1993. A transition to rearing the Methow Composite stock which is a combination of Chewuch River and Methow River stocks began in 1998. A well developed monitoring and evaluation program is associated with the program which informs the operation of the program. In a manner similar to the Chiwawa Program described above, the monitoring and evaluation process is intended to ensure that the program is constantly improving over time.

13.2.2.1.1 Broodstock History. The Methow Hatchery has actively managed broodstock collection and mating to maintain stock structure of separate populations in the Chewuch, Twisp and Methow Rivers, including final acclimation and release from tributary ponds. Initially broodstock was intended to include only natural-origin fish to ensure that the program was fully integrated with the natural population. The maintenance of tributary stocks has been difficult because of low adult returns to the basin and confounded by the Winthrop NFH propagation of Carson stock (an out of ESU stock). In 1995, all broodstock were collected at the Methow Hatchery outfall or were transferred from Winthrop NFH which collected fish that volunteered into their facility. In 1996 and 1998, the entire run was collected at Wells Dam because the total run of spring chinook salmon to the Methow River was very small. In 1997, 1999, and 2000, broodstock were collected at Wells Dam and as voluntary returns to the Methow Hatchery outfall. In the remaining years, broodstock was collected from tributary traps and the Methow Hatchery outfall.

Broodstock collection at locations other than tributary traps was not conducive to preserving stock structure. Starting in 1996, scale reading, elemental scale analysis, and extraction/reading of coded wire tags were used to identify salmon from the tributary populations. Specific mating was done each year to preserve the tributary stock structure and reduce the incorporation of Carson stock fish into the Methow Hatchery programs. In 1998, the Chewuch.and Methow

Rivers broodstock were combined to develop the Methow Composite stock. Since its inception, the Methow Composite stock has been made up of 88 percent hatchery-origin fish, the most recent three broods have averaged 97 percent hatchery-origin fish.

13.2.2.1.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. Several brood groups have been influenced by the Carson stock spring chinook salmon released from Winthrop NFH just downstream of the Methow Hatchery. Genetic analysis has shown that some release groups are similar to the Carson stock. Considering the substantial changes in the implementation of the Methow River program, studies to evaluate the genetic profile of adults which return compared to the subsequent naturally produced smolts and adults are warranted. As was noted above in the Chiwawa Program, age-at-return is younger overall for the hatchery-origin salmon compared to naturally produced salmon. Twenty and 70 percent of hatchery-origin fish return as three and four year olds, respectively, compared to the natural-origin fish for which return percentages are 9, 37, and 55 for three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish) (M. Humling, WDFW, pers. com.).

13.2.2.1.3 Program Design. The Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The annual production level of the Methow Hatchery as a whole was initially set at 738,000 and subsequently reduced to 550,000 smolts in 1998 because of a change in rearing criteria. The 550,000 smolts production level is generally intended to be equally divided among the three release ponds. This results in a production level of about 184,000 Methow Composite stock smolts for release into the Methow River annually. Actual program releases have ranged from about 4,400 smolts in 1994 to about 332,000 smolts in 1997. The years of small production level were the result of low run sizes, ineffective traps, and prioritizing maintaining stock integrity over achieving a target production level. In the early years of the program all smolts were marked with and adipose fin-clip and coded-wire tag. In more recent releases, smolts have not been fin-clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD) and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and Winthrop NFH programs combined) contributed 96 percent of the natural spawning population in the Methow River during 2001-2003.

The program is intended to foster natural production by contributing adults to the spawning population. The collection of nearly 100 percent of the run in two years and difficulty in collecting natural-origin fish for broodstock has resulted in over 88 percent hatchery-origin fish in the annual broodstocks consistently. Smolt release-to-adult return survival was 0.81 percent

for the 1998 brood (the only complete life cycle of the Methow Composite stock) (A. Murdoch , WDFW, pers. com.). Prior to using the Methow Composite stock the Methow River stock program averaged a release-to-adult survival of 0.29 percent (A. Murdoch, WDFW, pers. com.). The stray rate of Methow Composite fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Foghorn Dam does not effectively block migration of spring chinook salmon in the Methow River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.1.5 Effects on VSP. The Methow Composite stock spring chinook salmon program at Methow Hatchery has been successful in returning adult salmon to the spawning grounds. The reproductive success of these fish is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. However, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, and tributary traps which are not effective in trapping adults. The low effectiveness of tributary traps has led to the collection of most broodstock at the Methow Hatchery outfall which is removed from the Methow River. It is unlikely that substantial numbers of natural-origin salmon would return to the off channel hatchery outfall, therefore few natural-origin fish are collected. This has likely had an adverse effect on the productivity on the stock in general because hatchery fish return at a younger age compared to natural-origin fish, and domestication effects are likely to adversely impact the stocks ability to successfully reproduce in the natural environment.

The spatial distribution of the population has been effected, at least in the short term, by the lack of natural production in two years (1996 and 1998) and the large concentration of hatchery-origin fish spawning near or below the Methow Hatchery release site. The diversity of the population has likely been decreased by the combining of the Methow River and Chewuch River stocks. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery-origin fish. The effect on productivity and diversity of the extreme management actions is not known at this time. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.2 Methow Composite Spring Chinook Salmon Program at Winthrop National Fish Hatchery

The Winthrop – Carson stock program is being phased out (last release of Carson crossed fish will occur in 2005 with the 2003 brood) in favor of rearing the Methow Composite stock. Methow Composite is a combination of natural-origin salmon from the Chewuch and Methow Rivers, with the goal of supplementing the natural population of both systems. Winthrop NFH is on the Methow River mainstem, approximately 72 km upstream of the confluence with the

Columbia River. The Winthrop NFH has planted spring chinook salmon into the Methow River from 1941-1961, and from 1974 to the present.

13.2.2.2.1 Broodstock History. Historically, broodstock for the Winthrop NFH were collected from salmon that voluntarily enter the hatchery facility ladder. Beginning in 1998, the Methow Composite stock program was developed, and the management objective of the Winthrop NFH was modified to support conservation of the localized stocks. In 2001, access to the hatchery ladder was blocked and excess hatchery-origin fish were forced to remain in the Methow River. Since that time, the Methow Hatchery and Winthrop NFH have worked together in broodstock collections and spawning activities which were described above in the Methow Hatchery section. Winthrop NFH has used few natural-origin fish for broodstock throughout its history of fish culture (Cooper *et al.* 2002).

13.2.2.2.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. The operational changes begun in 2001 to phase out Carson stock in favor of the Methow Composite stock are intended to increase the similarity of the hatchery-origin and natural-origin fish. Considering the substantial program changes, studies to evaluate the genetic profile of the hatchery-origin and natural-origin fish are warranted. As was noted above in the Chiwawa Program, age-at-return is younger overall for the program salmon compared to naturally produced salmon with four year olds making up 91% of the adult hatchery-origin returns from 1993-1998 (Cooper *et al.* 2002).

13.2.2.2.3 Program Design. The spring chinook salmon program operated by the USFWS at Winthrop NFH releases Methow Composite stock into the Methow River was originally designed to provide spring chinook salmon for harvest. Best management practices are not consistently achieved at this facility. Since the ESA listing of the UCR spring chinook salmon ESU, it was determined that the program rearing Carson stock spring chinook salmon could not be operated in a manner consistent with recovery objectives and the USFWS made the decision to switch to propagating the Methow Composite stock in order to contribute to the recovery of the Methow population of spring chinook salmon in the natural environment. The annual target production level is 600,000 smolts. In the early years of the program only a portion of the smolts released were marked with and adipose fin clip and coded-wire tag. Recent releases of Carson stock were 100 percent adipose fin clipped and coded-wire tagged for identification purposes. Releases of Methow Composite stock have not been fin clipped, but they are coded-wire tagged for monitoring purposes.

13.2.2.2.4 Program Performance. This program is expected to continue into the foreseeable future with funding from the Bureau of Reclamation. The program consistently achieves annual release levels close to the target level of 600,000 smolts. This program has prioritized reaching production levels over maintaining stock structure as a general management practice.

Redd counts and carcasses sampled on the spawning grounds as part of the Methow Hatchery program monitoring described above were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and Winthrop NFH programs combined) contributed 96 percent of the fish on

the spawning grounds in the Methow River in recent years (Hubble and Theis 2003; Cooper *et al*. 2002).

Smolt release-to-adult return survival for the Methow Composite stock released from Winthrop NFH are not available yet. Historically, adult returns were allowed to voluntarily enter the Winthrop NFH fish ladder. Broodstock were retained from these volunteers and the excess salmon were given to Indian Tribes to fulfill harvest allotments. In 2001, access to the hatchery facility was blocked and the excess fish were forced to remain in the Methow River. A substantial number of these fish spawned in close proximity to the hatchery outlet. The effect of this large concentration of spawners on the natural production of the Methow River is not known. The stray rate of Methow Composite fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Foghorn Dam does not effectively block migration of spring chinook salmon in the Methow River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.2.5 Effects on VSP. The effect of the Winthrop NFH Methow Composite stock programs on abundance is intended to be positive. However, data which support a positive effect are lacking. The reproductive success of hatchery-origin fish on the spawning grounds is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. But, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, tributary traps which were not effective in trapping adults. The low effectiveness of tributary traps has led to the collection of most broodstock at the Methow Hatchery outfall which is removed from the Methow River. It is unlikely that substantial numbers of natural-origin salmon would return to the off channel hatchery outfall, therefore few natural-origin were collected.

The spatial distribution of the population, at least in the short term, has been effected by hatchery-origin fish not being allowed to enter the hatchery ladder. This has resulted in a large concentration of spawning fish near or below the Winthrop NFH release site. The diversity of the population has likely been decreased by the historic use of Carson stock at that Winthrop NFH and subsequent combining of the Methow River and Chewuch River stocks. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery reared fish. In the long term, the phasing out of Carson stock in favor of the Methow Composite stock is assumed to offer greater potential benefits to the recovery of the listed population. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.3 Chewuch River Spring Chinook Salmon Program

A Chewuch River stock was initially maintained at the Methow Hatchery, but a transition to the Methow Composite stock was initiated in 1998. Future releases will be the Methow Composite

stock. This program is about one third of the Methow Hatchery spring chinook salmon program described above.

13.2.2.3.1 Broodstock History. The first smolt releases were the progeny of natural-origin fish collected at Fulton Dam, on the Chewuch River, and from fish gaffed from the Chewuch River were first released into the Chewuch River in 1992. The Chewuch River stock was used from 1992 through 1997. As was the case with the Methow River stock, collection of broodstock was difficult because of low run sizes and ineffective tributary traps. Starting in 1998, the program transitioned to the Methow Composite stock (combined Methow River and Chewuch River stocks). Exclusion of Carson stock fish for broodstock was achieved as previously described using scale analysis and reading coded-wire tags at spawning. An average of 97 percent of the broodstock has been hatchery-origin fish in 2001-2003.

13.2.2.3.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. However, to a larger extent that the Methow River stock, the Chewuch stock is assumed to has maintained a closer resemblance to the natural-origin stock. This was done by selective incorporation of known Chewuch River natural-origin fish collected at Fulton Dam and known hatchery-origin returns from previous releases from Chewuch Pond. Genetic analysis has shown that the Chewuch Pond release groups were more similar to the natural-origin fish compared to the Methow River fish (Ford *et al.* 2001). Considering the substantial changes in the implementation of the Chewuch River program, studies to evaluate the genetic profile of the stock are warranted. Age-at-return is younger overall for the program salmon compared to naturally produced salmon with three and four year olds making up 20 and 70 percent, respectively, of the adult hatchery-origin returns compared to the natural-origin fish returning as 9, 37, and 55 percent three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish).

13.2.2.3.3 Program Design. As described above, the Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The Chewuch program production level is about 183,000 spring chinook salmon smolts for release into the Chewuch River annually. Actual program releases have averaged 123,970 since the program was started in 1992. The average production achieved is less than the target level because of low run sizes, ineffective traps, and the prioritization of maintaining stock integrity over achieving a target production level. In the early years of the program all smolts were marked with and adipose fin clip and coded-wire tag. In more recent releases smolts have not been fin clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.3.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD), and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program

contributed 64 percent of the broodstock over the last six years and 81 percent in the most recent three years.

Smolt release-to-adult return survival average was 0.09 percent (1992-1997) (A. Murdoch, WDFW, pers. com.). Smolts released from the Chewuch Pond tend to return to the Chewuch River or stray into the Methow or Twisp Rivers. The stray rate of Chewuch Pond released fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Fulton Dam does not effectively block migration of spring chinook salmon in the Chewuch River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.3.5 Effects on VSP. The Chewuch River spring chinook salmon program at Methow Hatchery has been successful in returning adult salmon to the Chewuch River spawning grounds. The reproductive success of these fish is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. However, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, tributary traps which were not effective in trapping adults.

The spatial distribution of the spring chinook salmon in the Chewuch River does not appear to have been effected. Adult returns to the program return to the Chewuch River and commingle with natural-origin returns. The diversity of the population has likely been decreased by the combining of the Methow River and Chewuch River stocks. Prior to 1998, the Chewuch stock was maintained as an separate stock which incorporated a substantial number of natural-origin fish into the broodstock annually. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery-origin fish. The effect on productivity and diversity of the natural-origin population is not known at this time. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.4 Twisp River Spring Chinook Salmon Program

Artificial propagation of the Twisp River stock began in 1992. This program is one third of the WDFW Methow Hatchery spring chinook salmon program previously described.

13.2.2.4.1 Broodstock History. Consistent with the original concept of the Methow Hatchery *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994), the Twisp River spring chinook salmon program broodstock has remained segregated from the other stocks. In 1992-1994 and again in 2001-2003, broodstock were collected using a temporary weir placed in the Twisp River. During the years when spring chinook salmon broodstock were collected at

Wells Dam (1996-1999) the Twisp stock fish were identified using elemental scale analysis and coded-wire tag reading during spawning. Additionally, some 1996 brood fish of Twisp stock were retained at the Methow Hatchery as a captive broodstock program which were incorporated in subsequent broods as the fish matured in captivity. An average of 57 percent of the broodstock has been hatchery-origin fish from 2001-2003. A novel technique for fish culture, preserving sperm by freezing (cryopreservation) has been done in many years. Occasionally, when no fresh milt was available, the frozen milt was used to fertilize eggs.

13.2.2.4.2 Similarity of Hatchery-origin and Natural-origin Fish. Program operational practices follow the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al*. (1993). Monitoring of this program includes periodic genetic analysis of hatchery-origin fish and natural-origin fish. Based on sampling conducted within the past ten years, the naturally produced and hatchery reared fish are genetically similar (Ford *et al*. 2001).

13.2.2.4.3 Program Design. As described above, the Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The Twisp program production level is 183,000 spring chinook salmon smolts for release into the Twisp River annually. In the early years of the program all smolts were marked with and adipose fin-clip and coded-wire tags. In more recent releases smolts have not been fin-clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.4.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD), and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Actual program releases have averaged about 66,700 smolts in the past three years. This reduced production level was the result of low run sizes, ineffective traps, and prioritizing maintaining stock integrity over achieving a target production level.

Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed 47 percent of the naturally spawning population over the last six years and 33 percent in the most recent three years (A. Murdoch, WDFW, pers. comm.). Age-at-return is younger overall for the hatchery-origin salmon compared to naturally produced salmon with three and four year olds making up 20 and 70 percent, respectively, of the adult hatchery-origin returns compared to the natural-origin fish which returned as 9, 37, and 55 percent three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish).

Smolt release-to-adult return survival average was 0.14 percent (1992-1997) (A. Murdoch, WDW, pers. com.). Smolts released from the Twisp Pond tend to return to the Twisp River or stray into the Methow River or Chewuch River at a relatively low rate. The stray rate of Twisp Programs fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

The Twisp weir is used during broodstock collection and is then removed from the river. Even when in place spring chinook salmon have been observed jumping over it and therefore, it is not a complete block to migration. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.4.5 Effects on VSP. The Twisp stock spring chinook salmon program has been successful in returning adult salmon to the spawning grounds. The reproductive success of these fish is not known. The effects on diversity are managed by incorporating natural-origin salmon and known Twisp hatchery-origin fish into the broodstock annually. The spatial distribution of the population appeared to be effected in the early years of the program with an increased percentage of redds being found below the weir. In the recent years, the weir is removed before the start of spawning and fish are able to reach the highest quality spawning habitats. Additional monitoring is needed to fully understand the effects of this program.

13.2.3 Entiat Basin Population

13.2.3.1 Entiat Basin Spring Chinook Salmon Program

Entiat NFH has released spring chinook salmon into the Entiat River annually since 1974. The program is intended to function as an isolated harvest augmentation program. The operation of the program is well established and has remained consistent over time. Salmon released from the Entiat NFH are not included in the UCR spring chinook salmon ESU.

13.2.3.1.1 Broodstock History. Egg sources have included the Cowlitz River, Carson NFH, Little White Salmon NFH, Leavenworth NFH, and Winthrop NFH. The last import of eggs or fish to the program was in 1994. Returning adults that voluntarily enter the hatchery were the primary broodstock in 1980 and continuously since 1982 (Cooper et al. 2002). Few if any natural-origin fish are incorporated into the broodstock.

13.2.3.1.2 Similarity of Hatchery-origin and Natural-origin Fish. Hatchery-origin fish and natural-origin fish were historically thought to remain segregated because hatchery-origin fish were assumed to voluntarily return to the Entiat NFH via a fish ladder which was open during the adult migration period. A review of genetic information conducted in 2001 supported that assumption (Ford *et al*. 2001). However, this assumption was not verified on the spawning grounds, as zero to few carcasses were sampled during the spawning ground surveys in the Entiat River in most years. Genetic sampling conducted more recently found that naturally produced smolts and Entiat NFH smolts collected in October 2001 and May 2002 were genetically similar (Ford *et al*. 2003). Spawning ground surveys in 2000-2003 have indicated that at least some Entiat NFH fish have commingled on the spawning grounds with the natural population. Similarities between hatchery-origin and natural-origin fish in terms of smolt-to-adult survival, age-at-return, and other characteristics are not known at this time.

13.2.3.1.3 Program Design. The Entiat NFH spring chinook salmon program is intended to function as an isolated program that does not substantially impact the natural population while providing salmon for harvest. Prior to 1998 brood only about 30 percent of each brood group was adipose fin-clipped and coded-wire tagged. Beginning with the 1999 brood each release group has been 100 percent adipose fin-clipped and coded-wire tagged.

13.2.3.1.4 Program Performance. The Entiat NFH yearling spring chinook salmon program estimated contribution to fisheries and hatchery returns from 1994-2000 (1990-1996 broods) was estimated at 0.16 percent (calculated using data from Cooper *et al*. 2002). Returns to the hatchery facility were 47 percent of the survival estimate. In 2001, spawning grounds surveys confirmed that, at least some hatchery-origin fish are bypassing the Entiat NFH ladder and spawning naturally. Genetic analysis of two brood years compared hatchery-origin smolts and natural-origin smolts and found that, at least for the two years sampled, the hatchery-origin fish are genetically similar to the natural-origin fish.

13.2.3.1.5 Effects on VSP. The artificial propagation of an out of ESU stock cannot improve any of the VSP criteria. In the case of the Entiat program fish that stray into natural production areas adversely effect the genetic diversity of the listed population. They also may displace the listed stock occupying the available habitat which alters the spatial distribution of the protected population. The productivity of the natural-origin population is likely reduced by the highly domesticated stock commingling on the spawning grounds which results in a lower abundance of the population intended to be protected under the ESA.

13.3 CONCLUSIONS

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

13.3.1 ESU Overview

13.3.1.1 History of Populations. The original number of populations is uncertain. Grand Coulee Dam blocked the entire Columbia Basin upstream from the facility, likely extirpating at least six populations. A seventh population might have existed in the Okanogan River basin (ICBTRT 2003).

Remaining populations exist in the Wenatchee, Methow and Entiat basins.

13.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

None. There are no listed populations in this ESU subject to minimal or less genetic influence from hatchery-origin fish. Artificial propagation programs are widespread in the Upper Columbia Basin. Hatchery programs operate in association with each of the three remaining spring chinook populations.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None.

Mixed (Integrated Programs[c])

Wenatchee basin: Chiwawa and White River programs
Methow basin: Methow Composite programs (Methow Hatchery and Winthrop NFH), Chewuch and Twisp programs

Hatchery (Isolated[d])

Wenatchee basin: Leavenworth program
Entiat basin: Entiat program
Methow basin: none

13.3.2 Summary of ESU Viability:

13.3.2.1 Abundance. The highest risk factors for this ESU are low abundance and low productivity (BRT 2003). See Table 13.2 for a summary of abundance information.

Natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin spring chinook included in the ESU) have increased since 1999, when the ESU was listed as endangered. Preliminary ESA abundance objectives or interim abundance targets (IAT) established by NOAA Fisheries for the Wenatchee, Entiat, and Methow basins are 3,750, 500, and 2,000 natural-origin spawners, respectively (Table 13.2). The Wenatchee averaged 3.5 percent of its abundance target for the five-year period prior to listing (1994-1998) and 15 percent of its target since listing (1999-2003). The Methow averaged 5.5 percent before listing and 26 percent since then.

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[a] See HLP for definition of natural, mixed, and hatchery populations.

[b] HLP Point 3.

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Table 13.2. Estimated escapement to the spawning grounds of Upper Columbia River spring chinook salmon. [a]

Return Year	Wenatchee Basin			Entiat Basin	Methow Basin		
	Hatchery	Natural	Total	Natural [b]	Hatchery	Natural	Total
1981		1,151	1,151			418	418
1982		1,359	1,359			531	531
1983		2,276	2,276			898	898
1984		1,893	1,893			750	750
1985		3,081	3,081			1,292	1,292
1986		1,935	1,935			789	789
1987		1,912	1,912			1,545	1,545
1988		1,517	1,517			1,633	1,633
1989		1,385	1,385			1,192	1,192
1990		771	771			825	825
1991		576	576			620	620
1992		1,097	1,097			1,479	1,479
1993	483	685	1,168			1,095	1,095
1994	94	185	279	112		269	269
1995	4	51	56	43		46	46
1996	49	122	171	53		0	0
1997	205	183	387	122	106	234	340
1998	60	119	179	79	0	0	0
1999	37	91	128	89	58	67	126
2000	301	363	664	101	659	122	781
2001	2,846	1,243	4,090	500	3,903	2,016	5,919
2002	911	747	1,657	211	1,701	353	2,054
2003	219	359	579	274	977	69	1,047
Average=	**474**	**1,004**	**1,231**	**158**	**1,058**	**706**	**1,064**
Years =	**11**	**23**	**23**	**10**	**7**	**23**	**23**
IAT [c]=			**3,750**	**500**			**2,000**

[a] *Expanded from redd counts, carcass surveys, and broodstock data, does not include broodstock retained from run. (T. Mosey, CPUD, pers. com; Carie 2000; D. Carie, USFWS, pers. com; A. Murduch, WDFW, pers. com.).*
[b] *An unknown number of these fish may be returns from the Entiat National Fish Hatchery spring chinook salmon program which is not included in the ESU.*
[c] *Interim abundance targets (Lohn 2002).*

In the Wenatchee Basin, one propagation program has added an average of 189 spawners annually to Chiwawa River spawning escapement. The White River captive broodstock program has not been in operation long enough to demonstrate any results. Abundance in the Entiat does

not benefit from the isolated program in operation there; this program is arguably detrimental to spring chinook salmon viability in the Entiat. In the Methow, integrated programs have increased the number of fish on the spawning grounds, but evidence is lacking to indicate that they are reproducing successfully.

13.3.2.2 Productivity. The highest risk factors for this ESU are low abundance and low productivity (BRT 2003). There is no known data indicating hatchery programs have changed ESU productivity.

13.3.2.3 Spatial Structure. Spatial structure status of the ESU, at least in the short term, has been adversely affected by the large numbers of hatchery-origin fish spawning near the Methow River hatchery facilities. The effects of collecting the entire Methow River basin run in 1996 and 1998 are not completely understood. Programs in this ESU are not reintroducing spring chinook into unoccupied habitats, and they do not present any significant obstacles or barriers to juvenile or adult distribution.

13.3.2.4 Diversity. The Chiwawa River and White River programs in the Wenatchee basin and the Twisp River program in the Methow basin appear to be preserving spring chinook salmon stock structure; however, the Entiat program and the two Methow Composite programs in the Methow basin are detrimental to preserving or restoring stock structure in those locations.

13.3.3 Artificial Propagation Record

13.3.3.1 Experience with Integrated Programs. In the Wenatchee, the Chiwawa program has been in operation for 15 years. The White River program is too new to produce adult returns. The Methow Hatchery programs have been in operation for 12 years.

13.3.3.2 Are Integrated Programs Self-Sustaining. Programs have not achieved program release targets in all years. Incorporation of natural-origin fish into the broodstocks is a crucial component of the operational plan of the integrated programs. This objective has been compromised in many of the years, particularly for the Methow basin hatchery programs.

13.3.3.3 Certainty that Integrated Programs will Continue to Operate. Each of the propagation programs in this ESU has long-term agreements and stable funding. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

13.3.4 Summary of Overall Extinction Risk Faced by the ESU

No populations in this ESU are demonstrating stable natural production. Total returns of both natural-origin and hatchery-origin fish included in the ESU peaked in 2001, and has since declined again. In the Methow, zero natural-origin fish have escaped to spawn naturally in two of the previous eight years and only 69 made it back to the Methow in 2003. Excluding 2001, the Wenatchee and Methow are averaging 10 percent and 8 percent of their abundance targets,

respectively, since 1999. In the Entiat, surveys are finding that Entiat NFH adult are not isolated from the natural population and is likely negatively impacting the ESU.

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